HW2

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Load in Data

```
d = read.table("T4-6.DAT")
```

Mardia Multivariate Normality Test

```
mvn(d, mvnTest = 'mardia')
## $multivariateNormality
##
               Test
                            Statistic
                                                  p value Result
## 1 Mardia Skewness 66.3397814411797
                                        0.922097864063478
## 2 Mardia Kurtosis -2.66574035625517 0.00768189967020949
                                                              NO
## 3
                MVN
                                 <NA>
                                                     <NA>
                                                              NO
##
## $univariateNormality
##
            Test Variable Statistic
                                       p value Normality
## 1 Shapiro-Wilk
                    V1
                              0.9749 0.0162
                                                  NO
                                                  NO
## 2 Shapiro-Wilk
                    ٧2
                              0.9779
                                       0.032
                    VЗ
                              0.9839 0.1269
                                                  YES
## 3 Shapiro-Wilk
## 4 Shapiro-Wilk
                    ۷4
                              0.9846
                                       0.15
                                                  YES
## 5 Shapiro-Wilk
                    ۷5
                              0.9626 0.0012
                                                  NO
## 6 Shapiro-Wilk
                    ۷6
                              0.6356
                                      <0.001
                                                  NO
                    ۷7
                                      <0.001
## 7 Shapiro-Wilk
                              0.6322
                                                  NO
##
## $Descriptives
                     Std.Dev Median Min Max 25th 75th
       n
              Mean
                                                              Skew
                                                                     Kurtosis
## V1 130 15.669231 5.8949308
                                 15
                                      3 31 11.25
                                                    19
                                                        0.42717915 -0.3713156
## V2 130 17.076923 4.1849034
                                 18
                                     6 27 14.00
                                                   20 -0.30997420 -0.4291609
## V3 130 18.784615 5.4630324
                                 19 2 29 15.00
                                                   22 -0.29888485 -0.2146062
## V4 130 15.500000 5.7482724
                                 16 1 27 11.25
                                                    19 -0.16098365 -0.6276702
## V5 130 11.730769 5.1921056
                                 11 2 29 8.00
                                                        0.66929028 0.1241775
                                                    15
## V6 130 1.523077 0.5013994
                                  2 1
                                          2 1.00
                                                     2 -0.09134199 -2.0069174
## V7 130
         1.446154 0.4990151
                                  1 1
                                          2 1.00
                                                     2 0.21414963 -1.9691099
```

Henze-Zirkler MVN test

```
mvn(d,mvnTest='hz')
```

```
## $multivariateNormality
```

```
p value MVN
             Test
                       HZ
## 1 Henze-Zirkler 1.262776 1.110223e-16 NO
## $univariateNormality
                                      p value Normality
            Test Variable Statistic
## 1 Shapiro-Wilk
                   V1
                            0.9749 0.0162
                    V2
                             0.9779
                                      0.032
## 2 Shapiro-Wilk
## 3 Shapiro-Wilk
                    VЗ
                             0.9839 0.1269
                                                 YES
## 4 Shapiro-Wilk
                    ۷4
                             0.9846
                                      0.15
                                                 YES
                    ۷5
## 5 Shapiro-Wilk
                             0.9626 0.0012
                                                 NO
## 6 Shapiro-Wilk
                    ۷6
                              0.6356 < 0.001
                                                 NO
## 7 Shapiro-Wilk
                    ۷7
                              0.6322 < 0.001
                                                 NO
## $Descriptives
                     Std.Dev Median Min Max 25th 75th
       n
              Mean
                                                             Skew
                                                                    Kurtosis
## V1 130 15.669231 5.8949308
                                15
                                     3 31 11.25
                                                   19 0.42717915 -0.3713156
## V2 130 17.076923 4.1849034
                                18
                                     6 27 14.00
                                                   20 -0.30997420 -0.4291609
## V3 130 18.784615 5.4630324
                                19
                                     2 29 15.00
                                                   22 -0.29888485 -0.2146062
## V4 130 15.500000 5.7482724
                                16 1 27 11.25
                                                   19 -0.16098365 -0.6276702
                                11 2 29 8.00
## V5 130 11.730769 5.1921056
                                                   15 0.66929028 0.1241775
## V6 130 1.523077 0.5013994
                                 2 1
                                         2 1.00
                                                    2 -0.09134199 -2.0069174
## V7 130 1.446154 0.4990151
                               1 1
                                         2 1.00
                                                    2 0.21414963 -1.9691099
```

Royston MVN test

```
mvn(d, mvnTest = 'royston')
## $multivariateNormality
       Test
                   Η
                          p value MVN
## 1 Royston 151.7001 9.065643e-30 NO
## $univariateNormality
            Test Variable Statistic
                                       p value Normality
## 1 Shapiro-Wilk
                    V1
                              0.9749 0.0162
                                                  NO
## 2 Shapiro-Wilk
                    ٧2
                              0.9779
                                       0.032
                                                  NO
## 3 Shapiro-Wilk
                    V3
                              0.9839 0.1269
                                                  YES
## 4 Shapiro-Wilk
                    ٧4
                              0.9846
                                       0.15
                                                  YES
## 5 Shapiro-Wilk
                    ۷5
                              0.9626
                                      0.0012
                                                  NO
## 6 Shapiro-Wilk
                    ۷6
                              0.6356
                                      <0.001
                                                  NO
## 7 Shapiro-Wilk
                    ۷7
                              0.6322
                                      <0.001
                                                  NO
##
## $Descriptives
       n
              Mean
                     Std.Dev Median Min Max 25th 75th
                                                              Skew
                                                                    Kurtosis
## V1 130 15.669231 5.8949308 15
                                      3 31 11.25
                                                    19 0.42717915 -0.3713156
## V2 130 17.076923 4.1849034
                                      6 27 14.00
                                 18
                                                    20 -0.30997420 -0.4291609
## V3 130 18.784615 5.4630324
                                 19
                                      2 29 15.00
                                                    22 -0.29888485 -0.2146062
                                 16
                                      1 27 11.25
## V4 130 15.500000 5.7482724
                                                    19 -0.16098365 -0.6276702
## V5 130 11.730769 5.1921056
                                 11
                                      2 29 8.00
                                                    15 0.66929028 0.1241775
## V6 130 1.523077 0.5013994
                                2
                                    1
                                          2 1.00
                                                     2 -0.09134199 -2.0069174
## V7 130 1.446154 0.4990151
                                 1
                                     1
                                          2 1.00
                                                     2 0.21414963 -1.9691099
```

Cramer Von Mises UVN test

```
mvn(d, univariateTest= 'CVM')
## Warning in FUN(newX[, i], ...): p-value is smaller than 7.37e-10, cannot be
## computed more accurately
## Warning in FUN(newX[, i], ...): p-value is smaller than 7.37e-10, cannot be
## computed more accurately
## $multivariateNormality
##
                Test
                              Statistic
                                                    p value Result
                                          0.922097864063478
## 1 Mardia Skewness 66.3397814411797
                                                                YES
## 2 Mardia Kurtosis -2.66574035625517 0.00768189967020949
                                                                 NO
                                                                 NO
## 3
                 MVN
                                   <NA>
                                                        <NA>
##
## $univariateNormality
                                             p value Normality
##
                 Test
                       Variable Statistic
                         V1
                                            0.0248
                                                         NO
## 1 Cramer-von Mises
                                    0.1481
## 2 Cramer-von Mises
                         V2
                                    0.2235
                                            0.0027
                                                         NO
## 3 Cramer-von Mises
                         VЗ
                                    0.0932
                                             0.138
                                                         YES
                         ٧4
                                            0.0923
## 4 Cramer-von Mises
                                    0.1059
                                                         YES
                         ۷5
## 5 Cramer-von Mises
                                    0.2559
                                            0.0011
                                                         NO
                         ۷6
## 6 Cramer-von Mises
                                    3.7887
                                            < 0.001
                                                         NO
## 7 Cramer-von Mises
                         ۷7
                                    3.8676
                                            <0.001
                                                         NO
## $Descriptives
##
                      Std.Dev Median Min Max 25th 75th
        n
               Mean
                                                                 Skew
                                                                        Kurtosis
## V1 130 15.669231 5.8949308
                                   15
                                        3
                                           31 11.25
                                                          0.42717915 -0.3713156
## V2 130 17.076923 4.1849034
                                        6
                                           27 14.00
                                                      20 -0.30997420 -0.4291609
                                   18
## V3 130 18.784615 5.4630324
                                   19
                                        2
                                           29 15.00
                                                      22 -0.29888485 -0.2146062
## V4 130 15.500000 5.7482724
                                   16
                                        1
                                           27 11.25
                                                       19 -0.16098365 -0.6276702
## V5 130 11.730769 5.1921056
                                   11
                                        2
                                           29
                                               8.00
                                                          0.66929028 0.1241775
## V6 130
          1.523077 0.5013994
                                    2
                                               1.00
                                            2
                                                        2 -0.09134199 -2.0069174
                                        1
## V7 130 1.446154 0.4990151
                                    1
                                        1
                                            2
                                               1.00
                                                          0.21414963 -1.9691099
```

Analysis

We cannot conclude that the data is multivariate normal, since all but the Mardia Skewness test rejected the null hypothesis. Moreover only variables V3 and V4 appear to be univariate normal. V3 and V4 were both labeled as univariate normal by the Shapiro-Wilik test and the Cramer Von Mises test, and both tests rejected the hypothesis of normality for all other vaiables.